

CONTACT SURFACES FOR ELECTRICAL CONTACTS

The present invention relates to improved contact surfaces for electrical contacts according to the definition of the species in the independent claim.

5 Related Art

Electrical connectors such as bushings and plugs are typically produced from a substrate made of an alloy on copper basis, which provides good electrical conductivity. If the electrical
10 connector is exposed to higher temperatures during operation, such as under the engine hood of a motor vehicle, the substrate is made from an alloy on copper basis having high stability and a high strain-relaxation resistance.

15 A cover layer is often applied on the substrate to reduce tarnishing of the copper-based substrate at higher temperatures and to improve the soldering ability. Typical cover layers are made of nickel, palladium/nickel alloys, tin or tin alloys. To minimize costs, tin is often used,
20 predominantly fire-tinned or galvanically deposited layers in the range of a few μm . Tin is characterized by its ductility and its excellent electrical conductivity.

The substrate is usually made of copper-based alloys such as
25 CuSn_4 -bronze, CuNiSi , etc., which often serve as base material for electrical plug-in connections. At higher temperatures it may happen that copper diffuses out of the substrate and combines with the tin, forming intermetallic compounds such as Cu_6Sn_5 and Cu_3Sn . The formation of such intermetallic compounds
30 reduces the quantity of unreacted or free tin on the surface. This has a detrimental effect on the electrical, corrosion and other performance characteristics.

A "tin layer" produced by heat treatment is known as thermo-tin, which is made of intermetallic phases to 100%. Also frequently used are AuCo alloys having nickel undercoating, and Ag surfaces, partly having copper undercoating or nickel undercoating.

So far, however, thermo tin has not shown to be a successful solution in all test situations (such as chemical testing or abrasive loading), and therefore has no more than a very small marketing share.

Moreover, it is known that tin alloys, due to their low hardness or their low wear resistance, have a tendency to increased oxidation (chafing corrosion) and to abrasion as a result of frequent plug-ins or vehicle-related or engine-related vibrations in the plug connector. This abrasion or chafing corrosion may lead to malfunctioning of a component (sensor, control unit, electrical components in general).

In addition, due to the high adhesion tendency and the plastic deformation, the plug forces are too high for many application situations such as plug connectors having a high number of poles) > 100 pins or contacts. Surfaces on the basis of tin and silver, in particular, have a cold welding tendency because of adhesion, and in self pairings are characterized by high friction values (coefficients of friction).

Even with conventional silver or gold layers, tribological wear mechanisms of the base material or the intermediate layer (frequently Cu or Ni) may occur with layer abrasion or layer chipping, due to poor adhesion.

EU directive "Altautorichtlinie" 2000/53 forbids the use of lead-containing tin layers. Since the lead inhibits whisker

formation (whiskers are tiny, hair-like crystals), galvanic pure tin promotes whisker growth, which may lead to short-circuits.

5 In U.S.-A 5,028,492, a composite coating for electrical contacts is described, which includes a ductile metal matrix and a uniformly distributed polymer component. The polymer component is present in a concentration that reduces the frictional forces that occur when a contact is inserted into a
10 corresponding receptacle. The composite coating provides lower friction and improved frictional oxidation compared to a galvanically deposited tin coating.

U.S.-A-5,916,695 discloses an electrical contact having a
15 copper-based substrate, which has been provided with a tin-based cover layer. To prevent diffusion of the copper from the substrate into the cover layer and the attendant formation of intermetallic layers, a barrier layer is applied between the substrate and the cover layer. This barrier layer contains 20
20 to 40 weight % of tin and preferably is mostly made up of copper (Cu base). Among others, the tin-based cover layer may include additives such as SiO_2 , Al_2O_3 , SiC , graphite or MoS_2 as lubricants.

25 Advantages of the Invention

In contrast to the related art, the contact surfaces according to the present invention have the advantage that they require low plug-in forces while still supplying excellent electrical
30 contacting.

Moreover, it is advantageous that they protect the surface from corrosion due to the antioxidants contained in the lubricant.

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Furthermore, there is the advantage of increased wear protection and thus of an increased service life of the contacts.

- 5 Advantageous further developments of the present invention result from the measures indicated in the dependent claims.

Brief Description of the Drawing

- 10 An exemplary embodiment of the present invention is represented in the drawing and elucidated in greater detail in the following description.

The figure shows the arrangement of the graphite particles in
15 an Ag contact layer.

Exemplary Embodiments

The core of the present invention is the construction of an Ag
20 cover layer, which has finely dispersed graphite particles embedded therein, on a copper-based substrate for electrical contacts in the automobile, which requires lower plug-in forces while providing the same satisfactory contacting.

25 As illustrated in the figure, an Ag contact surface 12 is first produced on the electrical contact, i.e., on copper-based substrate 10, using galvanic methods such as baths or reel-to-reel methods.

30 The Ag layer may be deposited with or also without intermediate layers as diffusion barriers, such as a tin undercoating, and also with or without flash of noble metals such as Au, Pt, Ru or Pd.

According to the present invention, the layer thickness of the deposited Ag layer is between approximately 1.0 and approximately 10 μm , depending on the application.

- 5 Finely dispersed graphite particles 14 have been introduced into the Ag layer, for instance by intermingling of graphite and chemical auxiliary agents for binding (wetting agent), the graphite quantities lying in the range of 1 to 3 weight % of carbon of the Ag layer, or in the range of 3 to 10 surface %
10 of carbon. The graphite particles are preferably present as platelets or flakes and have a length of between 1 and 10 μm , a thickness in the range of 0.05 to 2 μm , and a width in the range of 0.05 to 2 μm . It is preferred if the maximum value for thickness and width, i.e., 2 μm , does not occur
15 simultaneously. In a preferred specific embodiment, the graphite particles are disposed anisotropically along the habitus plane of the Ag layer, i.e., along the longest axis of the layer plane (cf. the figure).
- 20 The aspect ratio of the graphite particles, i.e., the ratio of length to thickness, preferably amounts to 1:2 to 1:40.

The contact surfaces according to the present invention allow lower plug-in forces as a result of the included graphite
25 lubricant. Good contacting is ensured by the electrical conductivity of the lubricant. Antioxidants contained in the lubricant protect the surfaces from corrosion, thus providing high wear resistance and a high number of plug-in cycles.

- 30 The contact surfaces according to the present invention are preferably used in electrical contacts in automotive plug connections that are in close proximity to the engine.